

Development and Psychometric Properties of the Smoking Restraint Questionnaire

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THE SMOKING RESTRAINT QUESTIONNAIRE

I declare that this research report is my own original work and that, to the best of my knowledge and belief, it does not contain material from published sources without proper acknowledgement, nor does it contain material which has been accepted for the award of any other higher degree or graduate diploma in any university.

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Foreword

This thesis is presented in two parts. Part one is a literature review on the topic of interest, smoking restraint. Part two is a manuscript that was accepted for publication with the Journal of Addictive Behaviors on 17/09/2015. Reviewer feedback is presented in Appendix B. To be consistent with the Instructions for Authors of this journal, the manuscript was written with US English spelling. As the literature review was not submitted for publishing, it was written in Australian English spelling to be consistent with thesis requirements.

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Abstract

Restraint is a component of self-control that focuses on the deliberate reduction of an undesired behaviour and is theorised to play a role in smoking reduction and cessation. However, there exists no instrument to assess smoking restraint. The current research was conducted in two parts. First, a literature review summarised the nature of smoking and its relationship with restraint. Second, the Smoking Restraint Questionnaire (SRQ) was developed and tested on a large sample of smokers. Participants were 406 smokers (48% female; 52.2% non-daily) with a mean age of 38.83 years ($SD = 12.05$). After completing a baseline questionnaire designed to assess smoking restraint, they also completed 21-days of ecological momentary assessment (EMA). During EMA they recorded each cigarette smoked and answered questions related to planned restraint every morning and restraint attempts every evening. The 4-item SRQ was found to fit a single factor ($RMSEA = .038$, $CFI = .99$, $TLI = .99$) and was internally consistent (composite reliability = .74). The questionnaire assesses the setting of weekly restraint goals and attempts at not lighting up when tempted to smoke. Participant SRQ scores related positively to EMA data on plans to restrain ($p < .001$) and frequency of restraint attempts ($p < .001$). The SRQ is promising as a measure of smoking restraint and may enable further research and insights into smoking reduction and cessation.

The Role of Restraint in Cigarette Smoking: A Literature Review

Cigarette smoking delivers psychoactive substances into the bloodstream that enter the brain and alter neurotransmitter release. Specifically, there is an upregulation of dopamine and glutamate, which is theorised to actively stimulate dependence (Ortells & Barrantes, 2010). According to the World Health Organisation and American Psychiatric Association, tobacco dependence is a diagnosable mental health disorder (American Psychiatric Association, 2013; World Health Organisation, 2005).

In addition to its classification as a mental disorder, cigarette smoking is considered one of the greatest global health concerns, as it is a leading cause of preventable death and disease burden in the world (Lim et al., 2012). Smoking decreases life expectancy and increases morbidity (Lim et al., 2012), and is a major risk factor for ischemic stroke (Hadjiev, Mineva, & Vukov, 2003), myocardial infarction (Yusuf et al., 2004), coronary heart disease (Kannel, D'Agostino, & Belanger, 1987), hypertension (Primatesta, Falaschetti, Gupta, Marmot, & Poulter, 2001), and chronic bronchitis (Meteran et al., 2012). It is associated with high lung cancer prevalence (Rachtan, 2002; Stellman et al., 2001) and emphysema (Bellomi et al., 2010), and can worsen spinal problems (Vogt, Hanscom, Lauerman, & Kang, 2002).

The negative effects of smoking are not circumscribed to smokers only. Several meta-analyses have found that passive smokers, non-smokers who are often in smoke environments and therefore passively inhale cigarette smoke, are at elevated risk of developing lung cancer (Taylor, Cumming, Woodward, & Black, 2001; Zhao et al., 2010). They also tend to have altered lung function (Janson et al., 2001) and are affected by smoking related economic deficits. In Australia alone, it is estimated that smoking costs the healthcare system \$31.5b per year, and that those at the lower end of the socioeconomic gradient are most affected (Australian Bureau of Statistics, 2009). Given the extensive health and financial burdens associated with cigarette smoking, there is great need to reduce these harms

by supporting smokers to reduce their intake and eventually quit. Unfortunately, as smoking is addictive, quit attempts often fail (Zwar et al., 2011). In order to support smokers to quit, smoking behaviours must be understood so that appropriate interventions may be employed. A construct theorised to be important for moderating the amount of cigarettes smoked is restraint, which refers to the ability to refrain from smoking when tempted (Nordgren, van Harreveld, & van der Pligt, 2009). In order to understand restraint within the context of smoking addiction, it is essential to review the models and theories of addiction and how these relate to smoking reduction. From this, a more comprehensive understanding of restraint might be gained with the potential for recommending strategies to operationalise the construct.

Models and Theories of Addiction

As substance use has been problematic throughout history, a great amount of research has been dedicated to delineating factors that maintain substance dependence. Over time, the breadth of research has grown substantially to include biological, sociological and psychological factors that maintain addiction, as well as understanding the types of addictions, such as psychoactive substances and gambling (Finocchiaro & Balconi, 2015). Although the models and theories of addiction described below have been developed on a diverse range of behaviours, the global pervasiveness of cigarette smoking and its associated harms has meant that a large body of research has been applied to smoking. As understanding behaviours is critical to effective treatments (Shiffman, 2006), the most prominent models of addiction and smoking maintenance are reviewed with the aim of introducing restraint as vital to the process of reducing cigarette intake.

Operant and classical conditioning

Operant and classical conditioning are archetypal behavioural models of learned behaviour. In operant conditioning, the frequency of a behaviour increases following the

introduction of pleasant stimuli (positive reinforcement) or removal of unpleasant stimuli (negative reinforcement) (Skinner, 1938). Conversely, behaviour frequency decreases through the introduction of unpleasant stimuli (positive punishment), or removal of pleasant stimuli (negative punishment) (Skinner, 1938). It is theorised that this is governed by dopamine, a neurotransmitter heavily implicated in learned behaviours (Wise, 2004). With regard to smoking, inhalation of tobacco smoke and the ingestion of nicotine catalyses a surge in dopamine release (Kleijn et al., 2011), which stimulates the reinforcement process. Smoking behaviour may be positively reinforced via positive effects of nicotine, such as a subjective 'high' (Lindsey et al., 2013), and negatively reinforced by removal of negative affect (Heckman et al., 2013).

Classical conditioning, on the other hand, theorises that behaviours become learned through the pairing of unconditioned stimuli with conditioned stimuli. The seminal example of classical conditioning comes from Pavlov's dog, in which a dog came to salivate upon hearing a bell, as it had learned that a bell typically preceded its meal (Pavlov, Gantt, Volborth, & Cannon, 1941). Several rat and human studies have demonstrated classical conditioning of smoking behaviour (Guy & Fletcher, 2014; Thewissen, Havermans, Geschwind, van den Hout, & Jansen, 2007; Winkler et al., 2011). From this perceptive, smoking addiction may reflect the development of conditioned environments and lifestyle patterns that maintain smoking, as the smoker is constantly cued to smoke by paired associations. For example, drinking venues often trigger smoking lapses, as many smokers associate drinking with smoking (Shiffman et al., 2014).

These models suggest that the maladaptive behaviour of smoking becomes entrenched through reinforcement and association from environmental stimuli. The operant model also reasons that cigarette addiction is maintained through negative reinforcement, as the dependent smoker avoids withdrawal symptoms through regular ingestion of nicotine. More

recently, Caggiula et al. (2009) proposed a dual-reinforcement model that combines elements of operant and classical conditioning. They propose that nicotine reinforces drug seeking behaviour and classically conditions previously neutral environmental stimuli. They also propose that nicotine reinforces related stimuli, such as drinking alcohol, and by doing so, potentiates the primary reinforcement and associations of nicotine. This theory summarises dual behavioural processes of addiction and their interaction, theoretically caused by nicotine. A limitation to this theory is a lack of empirical evidence to substantiate claims that nicotine facilitates an interaction between reinforcement and association of smoking behaviour. Furthermore, these behavioural models do not account for all types of smokers, such as long-term, intermittent smokers (Shiffman, Ferguson, Dunbar, & Scholl, 2012). Nonetheless, these models suggest that smoking becomes a learned behaviour that it is difficult to stop. Thus, to quit, one must be able to refrain from a learned and frequently cued behaviour, which would presumably require awareness of behavioural and psychological strategies to overcome the smoking habit. However, as this approach to understanding smoking behaviour does not account for different smoking frequencies, the behavioural model is typically incorporated into broader theories of smoking, such as the biopsychosocial model.

Biopsychosocial model

The biopsychosocial model, developed by Engel (1977), is a generic model of physical and mental health. It posits that biological, psychological and sociological factors impact health outcomes through the development of illness and regulation of health-seeking behaviours. Biological factors of cigarette dependence may be indicated through genetic research. For example, Schuck, Otten, Engels, and Kleinjan (2014) found that genetic variations accounted for differences in subjective experience amongst 171-adolescents who had never inhaled a cigarette. Specifically, adolescents with a specific genetic variant were more likely to enjoy their first dose of nicotine than other adolescents. The findings are

congruent with a biopsychosocial model of drug use, as it was also found that adolescents exposed to peers and parents who smoke were more likely to enjoy the novel dose of nicotine compared with those who did not have this environmental exposure. That is, sociological and genetic risk factors for smoking uptake were indicated in this research.

In addition to familial and peer smoking risk factors, socioeconomic status and social class have been implicated in smoking uptake. Economic analyses across four Western countries found that lower socioeconomic status and social class were associated with greater risk of smoking uptake, and smoking related mortality and morbidity (Jha et al., 2006). This is consistent with longitudinal research that has identified lower socioeconomic status as a significant predictor of smoking uptake and heavier smoking (Joffer et al., 2014; Mathur, Erickson, Stigler, Forster, & Finnegan, 2013). Furthermore, lower parental education is also a risk factor for adolescent smoking uptake (Joffer et al., 2014). Overall, poorer social circumstances are a risk factor for cigarette consumption.

Similar to the social aspect of the biopsychosocial model, psychological risk factors for smoking uptake include poorer mental health. Individuals with post-traumatic stress disorder are at elevated risk of smoking (Fu et al., 2007), as are those with mood disorders (Khaled et al., 2012). Smoking is also more common amongst those with problematic alcohol use (Kelly, Grant, Cooper, & Cooney, 2013), anxiety (Collins & Lepore, 2009), and stress (Chung & Joung, 2014). Other psychological factors that contribute to smoking uptake include particular personality traits (Conner, Grogan, Fry, Gough, & Higgins, 2009; Terracciano & Costa, 2004), and learning, such as operant and classical conditioning. Therefore, from the perspective of the biopsychosocial model, smoking reduction and quitting would require extensive intervention, including behavioural and psychological strategies (e.g., refusal skills, coping skills), and medical intervention (e.g., nicotine replacement therapy).

Cognitive deficits model

Although fewer people are starting to smoke (Wakefield et al., 2014), the continual uptake of cigarette smoking across generations has led some researchers to investigate cognitive deficits implicated in the behaviour. According to Lubman, Yüeel, and Pantelis (2004), drug addicted individuals present with deficient inhibitory control. Their inhibition dysregulation theory posits that the symptoms of addiction are similar to obsessive-compulsive disorder, as both feature poor inhibition of unhelpful thoughts and behaviours. They use neuropsychological data (e.g., Barnett et al., 1999; Bechara, Hinds, & Dolan, 2002) to draw similarities between the mental health conditions, and identify deficits in the orbito-frontal cortex and anterior cingulate cortex that may account for this. Application of the theory to cigarette smoking may be limited as the authors mostly summarised data from alcohol and illegal drug use studies. Conversely, the theorisation that dysregulated inhibition perpetuates drug use is consistent with findings in the smoking literature, as impulsivity, the inverse of inhibition, is typically elevated amongst smokers (VanderVeen, Cohen, Cukrowicz, & Trotter, 2008).

A similar cognitive deficits theory by Volkow, Fowler, and Wang (2003) posits that drug intoxication over activates motivational and memory neural circuitry of pleasant experiences, resulting in deactivation of inhibitory controls hosted in the prefrontal cortex. They theorise that intoxication drives drug seeking through the temporary impairment of executive functions responsible for behavioural self-regulation. Through regular ingestion of a substance, the behaviour becomes entrenched, as does the neural circuitry underlying this cognitive deficit. Unlike the theory by Lubman et al. (2004), this neuro-cognitive model was developed with direct consideration of smoking data. However, unlike the former model, it has been extensively tested and has formed the basis of peer-reviewed research for several decades (Volkow & Morales, 2015). The available data indicate that poorer inhibition

maintains smoking behaviour, suggesting that the ability to resist impulses is critical to smoking reduction and cessation (Volkow & Morales, 2015). This ability is reflected in the restraint construct (Nordgren et al., 2009).

Allosteric modulation and opponent-processes

The predominant neural model of dependence posits that regular substance abuse alters homeostatic set points of neural activity whilst affecting mood and cognitions (Koob & Le Moal, 2001; Levy, Barto, Levy, & Meyer, 2013). This is termed allosteric modulation or the opponent-process model (Gutkint, Dehaene, & Changeux, 2006). This model theorises that a drug user comes to need the substance in order to feel normal, as the regular ingestion of a drug alters allostasis, the process of achieving homeostasis (Levy et al., 2013). Levy et al. (2013) described that the ingestion of nicotine affects neural activity in several brain regions, including the nucleus accumbens, ventral tegmental area, pre-frontal cortex, orbitofrontal cortex, and anterior-cingulate cortex. They theorise that this relates to behavioural reinforcement of drug taking, and changes in mood and cognition. As nicotine increases activity in several brain regions (Wylie, Tanabe, Martin, Wongngamnit, & Tregellas, 2013), it is believed that this triggers an opponent process to decrease the intensity of that experience (Watkins, Koob, & Markou, 2000). The opponent-process dips neural activity below the set point and is generally slow to return to normal. Through regular ingestion of nicotine, the opponent-process may cause mood and neural activity to spend more time below the homeostatic set point. The smoker then comes to need nicotine in order to return neural activity and mood to the set point sooner (Watkins et al., 2000). This allosteric modulation is theorised to account for tolerance and withdrawal effects of addicted smokers, as the addicted individual's baseline functioning changes so that the same drug potency has less of an impact (Watkins et al., 2000). The person then becomes dependent as

they begin to need the substance in order to operate at a level that is typical of people without substance dependence.

This theory expands on the motivational opponent-process theory of addiction (Solomon & Corbit, 1973). In this theory, smoking related pleasure (e.g., improved mood, increased alertness) activates delayed opponent-processes of craving, loss of pleasure, and withdrawal symptoms. Again, the regular ingestion of nicotine is theorised to activate opponent-processes that are more time consuming than the drug's positive effects. The individual is then motivated to use the drug regularly to avoid the negative opponent-process effects (i.e., withdrawal avoidance).

It is also theorised that allosteric modulation occurs through a down-regulation of dopamine activity (Mugnaini et al., 2006). Down regulation of dopamine is related to elevated impulsivity (Dalley et al., 2007), indicating an interaction between biological and personality factors, similar to the biopsychosocial model of dependence. For smokers, greater impulsivity heightens the risk of cigarette smoking and relapse (Doran, Spring, McChargue, Pergadia, & Richmond, 2004; VanderVeen et al., 2008).

In summary, modern theories of smoking addiction are broadly based on the biopsychosocial model of health behaviour. These theories describe genetic, neural, cognitive, behavioural, environmental, and psychological factors that motivate substance use and withdrawal avoidance. Furthermore, the pharmacodynamics of nicotine are theorised to potentiate these processes, resulting in smoking behaviour that is highly addictive and self-reinforcing. Therefore, successful smoking reduction and quitting may require a variety of interventions, several of which are similar in their expectation that the smoker be able to exercise self-restraint when tempted to smoke.

Quitting

Given the high level of mortality and morbidity associated with smoking, there is increasing pressure from health authorities to support successful cessation attempts. As unassisted cessation attempts are less successful than assisted attempts (Mottillo et al., 2008), which generally feature cutting down cigarette intake, emphasis should be placed on cutting down as a pathway to abstinence. This can be achieved through behavioural and pharmacological interventions (Oostveen, van der Galien, Smeets, Hollinga, & Bosmans, 2015).

A Cochrane review of pharmacological treatments for smoking cessation found that Bupropion, Varenicline, and Cytisine improved chances of quitting by up to 80% (Cahill, Stevens, Perera, & Lancaster, 2013). These medications work in quite different ways. For example, Bupropion is an antidepressant that relieves withdrawal symptoms associated with smoking cessation (Cahill et al., 2013). Varenicline and Cytisine, however, work to reduce cravings and stifle the pleasurable effects of nicotine, so there is less reinforcement from smoking (Cahill et al., 2013). Whilst these interventions are effective at improving the chances of quitting, they do not address all aspects of the biopsychosocial model of addiction. Therefore, it might come with little surprise that combination pharmacological and behavioural treatment for smoking cessation is most effective (Oostveen et al., 2015).

Behavioural interventions are highly variable and may include telephone counselling, group therapy, e-Counselling, and individual therapy. The treatments typically involve assessing the severity of the quitter's addiction, providing education about the harms associated with smoking, and negotiating strategies to help reduce cigarette intake or stop altogether (Perkins, Conklin, & Levine, 2007). Smoking reduction programs can be very effective at supporting quitters to achieve abstinence (Klemperer & Hughes, 2015), as gradual change is encouraged through various psychological and behavioural techniques.

These might include self-distraction, relaxation training, goal setting, and cue-controlled exposure (Perkins et al., 2007).

Similar across these interventions is the expectation that quitters reduce their cigarette intake by improving the ability to resist smoking under temptation. The ability to set smoking reduction goals and resist smoking is reflected in the construct of restraint, which is theorised to be integral to a variety of health driven behaviours, such as smoking cessation (de Ridder, Lensvelt-Mulders, Kinkenaar, Stok, & Baumeister, 2011). As effective treatments require a thorough understanding of the variables that facilitate change (Shiffman, 2006), there may be great value in understanding the nature of restraint in smoking reduction and cessation.

What is Restraint?

Many mechanisms are theorised to improve the chances of successful quitting, including self-control. Self-control is the ability to increase the occurrence of desirable behaviours and decrease the occurrence of undesirable behaviours (de Ridder et al., 2011). As a psychological construct, restraint fits within the biopsychosocial model of addiction and, theoretically, those with greater restraint should be better at reducing their cigarette intake. Restraint is a broad construct that involves self-regulating thoughts, feelings, and behaviours. Similarly broad is the concept of self-regulation, which is theorised to be a personality construct for which dispositional self-control is a prerequisite (Baumeister, Gailliot, DeWall, & Oaten, 2006). Self-regulation purportedly relies on natural energy sources, so that immediately after self-controlling one's behaviour, one has a depleted energy source and is at risk of lapse (Baumeister et al., 2006). These concepts are similarly broad and propose that behaviour can be modified in line with a person's wishes. They are also demonstrably related to smoking cessation and have provided insight into smoking behaviour (Baumeister et al., 2006). However, smoking cessation invokes only half of the self-control and self-regulation definitions, in that the focus is solely on decreasing the occurrence of an undesired behaviour.

This implicates the need to investigate restraint further as it specifically addresses behaviour reduction.

Similar to self-regulation, restraint has been defined as the conscious, chronic restriction of a target behaviour based on personally set limits (Keller & Siegrist, 2014). Restraint has mostly been studied in the eating literature (e.g., binge-eating) where it can be accomplished through a variety of behaviour strategies, such as setting limits on daily and weekly caloric intake, avoiding places where eating is expected (planned restraint), or providing excuses when food is presented (situational restraint) (Moreno, Warren, Rodríguez, Fernández, & Cepeda-Benito, 2009). Moreno et al. (2009) described the strategies as strict and self-imposed, with some behaviour demonstrating temporal effectiveness. For example, refusal skills are essential to achieving restraint when it is momentarily required (Vandereycken & Van Humbeeck, 2008), whereas planning skills are essential to setting caloric intake restraint goals (Segura-García, De Fazio, Sinopoli, De Masi, & Brambilla, 2014).

The eating definition of restraint is equivalent to that provided in the smoking literature, in that smoking restraint is a conscious, cognitive and behavioural ability to refrain from consumption (Nordgren et al., 2009). Craving often prompts smoking, so deliberately resisting smoking may require the application of immediate, situational restraint (Shiffman, Ferguson et al., 2012). Among smokers who have quit, temptations to smoke, characterised by strong craving, frequently present challenges to the individual's commitment to abstinence (Ferguson & Shiffman, 2009) and analysis shows that whether the person actually succumbs can be influenced by whether they implement restraint strategies (i.e., coping; Shiffman, 1982, 1984; Shiffman et al., 1996; van Osch, Lechner, Reubsaet, Wigger, & de Vries, 2008). More strategic, planned restraint strategies that are not enacted at the moment of temptation,

but distal to such critical moments, have also been described (i.e., "anticipatory coping"; van Osch et al., 2008; Wills & Shiffman, 1985).

Less has been studied about the role of restraint in smoking reduction, rather than complete cessation, but there has been increased interest in reduction, either as a harm-reduction strategy (Hamilton, Cross, Resnicow, & Hall, 2005) or as a path to cessation (Shiffman, Ferguson, & Strahs, 2009). Studies show that smokers who are better able to reduce their smoking are also more likely to quit completely (Klemperer & Hughes, 2015; Moore et al., 2009) suggesting a link or continuity between restraint for reduction and for cessation.

Despite interest in the area, there is currently no smoking restraint assessment tool. This is disappointing given that restraint assessments have benefitted health outcomes and research in other areas (Jacobi, Völker, Trockel, & Taylor, 2012). It is also surprising given that the construct was theorised decades ago to account for smoking fewer cigarettes (Herman, 1974). The existence of assessments for eating restraint and alcohol restraint indicate that the construct can be operationalised with good effect. For example, the Temptation and Restraint Inventory (TRI; Collins & Lapp, 1992) measures alcohol specific restraint with self-report items that assess the use of emotions to motivate drinking less (e.g., guilt) and general attempts at drinking less. The questionnaire has good internal consistency (alphas from .76 to .91), concurrent validity, and is predictive of weekly drinking and alcohol problems (Collins, Koutsky, & Izzo, 2000; Collins & Lapp, 1991). The good psychometric properties of the TRI, particularly concurrent and predictive validity, indicate that the measurement of restraint has important implications for understanding the success and failure of quit attempts. Thus, the valid measurement of smoking restraint may provide valuable insight into the psychological enablers of successful smoking cessation.

Other existing restraint self-report assessments include the Restrained Drinking Scale (Ruderman & McKirnan, 1984), the Eating Disorders Examination – Questionnaire (Fairburn & Beglin, 1994), The Restraint Scale (Herman & Mack, 1975), The Three Factor Eating Questionnaire (Stunkard & Messick, 1988), and the English version of the Dutch Eating Behaviour Questionnaire (Van Strien, 2002). Similar across these assessments are the inclusion of items that reference general attempts at restraining/cutting down, situation specific behaviours (e.g., taking small helpings of food), and cognitive strategies (e.g., distraction, setting limits). In all cases, restraint is indicated by a single factor and the authors converge on a definition that restraint is the ability to employ cognitive and behavioural strategies to limit the intake of a substance. This is consistent with the definition proposed in the smoking literature (Nordgren et al., 2009), which might suggest that smoking restraint can also be operationalised with a self-report questionnaire.

The absence of a smoking restraint assessment tool has imposed substantial limitations to scientific understandings of the construct and treatment delivery. Clinical researchers in the alcohol field identify the construct to be of importance in drinking reduction and as a potential target for treatment (Jones, Cole, Goudie, & Field, 2011; Tahaney, Kantner, & Palfai, 2014). Similarly, some clinical researchers have developed smoking treatments that purportedly improve restraint (Kelly, Zuroff, Foa, & Gilbert, 2010; Bayot, Capafons, & Cardeña, 1997; Capafons & Amigó, 1995; Muraven, 2010). However, this catalyses concern about adherence to the scientist-practitioner model as smoking restraint is yet to be operationalised. That is, interventions are being delivered for which a primary variable cannot be measured. In fact, the studies supporting these interventions do not measure restraint, self-control, or self-regulation, so there is no evidence that these treatments improve these abilities.

Despite the absence of high-quality clinical research on smoking restraint, the availability of alcohol and eating restraint assessment tools has provided insight into its role with cessation generally. For example, eating restraint was found to be negatively associated with impulsive decision making (Stojek, Fischer, Murphy, & MacKillop, 2014), which is contrary to findings of elevated impulsivity amongst smokers (Doran et al., 2004; VanderVeen et al., 2008). Thus, retrained eaters may demonstrate lower impulsivity as they choose a delayed reward (e.g., weight loss) over immediate gains (e.g., hunger satiation), and smokers choose an immediate reward (e.g., nicotine intoxication, withdrawal avoidance) over delayed gains (e.g., better health). This is consistent with the definition of impulsivity as reflecting a preference for smaller immediate rewards over larger delayed rewards through quick decision making without troubleshooting the consequences of that decision (Stojek et al., 2014). For smokers, elevated impulsivity predicts relapse and maintenance of smoking status (Doran et al., 2004; VanderVeen et al., 2008), which is consistent with the biopsychosocial models of smoking.

Although the measurement of impulsivity has been beneficial to understanding the restraint construct, it does not identify specific strategies that enable smoking cessation. According to counteractive self-control theory, it is the activation of appropriate restraint behaviours that facilitate successful self-control (Myrseth, Fishbach, & Trope, 2009). Therefore, quitters are likely to benefit from adopting behaviours that support their endeavour. The alcohol and eating restraint assessment tools may provide insight as to how smokers may do this. These tools reference general attempts to restrain, situational behaviours, and limit setting as strategies that validly predict successful restraint. Therefore, in support of better health and economic outcomes, the development of a valid and reliable smoking restraint assessment tool is essential. The process of developing and testing the assessment tool would identify smoking restraint strategies that enable successful cessation.

The tool could be used clinically to monitor change, as quitters may be encouraged to enact the assessed behaviours.

Principles of Scale Development

The principal goals of scale development are to achieve good reliability and validity. Reliability refers to the consistency with which items relate to one another, the consistency with which they measure a construct over time, and the consistency of measurement across various raters (DeVellis, 2012). Reliability is a necessary pre-requisite to validity, which refers to the accuracy with which a scale measures a chosen construct. Validity has been conceptualised in many ways, although content validity, criterion-related validity, and construct validity are predominant (Cronbach & Meehl, 1955; Messick, 1995). Content validity is the extent to which a set of items represents a construct. Criterion-related validity encompasses how accurately a score on a scale predicts actual behaviour or real-world events (predictive validity), correlates with a similar measure (convergent validity), predicts outcomes of similar measures (concurrent validity), and correlates with a dissimilar measure (divergent or discriminant validity). Construct validity, on the other hand, refers to how well a scale measures an intangible variable, such as smoking restraint. Unlike cigarette intake, restraint cannot be observed or assessed by counting or recording. Simply, it is the ability to self-control one's behaviour. Therefore, the accurate assessment of restraint relies on determining how well a data set indicates construct validity through statistical analyses.

Cronbach and Meehl (1955), who pioneered scale development theory, suggested that when statistical inferences do not support the indication of construct validity, three interpretations may occur. These are that the assessment tool does not measure the target variable, that the theoretical basis for the measure is inaccurate, and/or that the research design used to test construct validity was inappropriate. These interpretations incite the

importance of working extensively to generate a list of theoretically guided items with good content validity, and testing these items according to established procedures.

Several authors (DeVellis, 2012; Netemeyer, Bearden, & Sharma, 2003) have outlined a systematic scale development process. These typically begin with defining the target variable in the context of a guiding theory. Next, potential items are generated and refined collaboratively to enhance content validity, then the scale is administered to a sample of participants to collect data. Reliability estimates may be analysed following an exploration of the questionnaire's factor structure. Once the factor structure has been refined, it may be confirmed through administering the assessment to a second sample. Alternatively, the explorative and confirmatory stages may be conducted within a single, large sample using random split-halves (DeVellis, 2012).

Although there is consistency in the general procedure of scale development, there is greater variability in the types of statistical procedures employed, interpretive guidelines, and reporting standards. For example, very few scale development studies adequately report the statistical procedures (Cabrera-Nguyen, 2010) and many psychometric studies use different estimation methods and interpretive criteria (Perry, Nicholls, Clough, & Crust, 2015; Toman, 2014). However, the use of principal components analysis in place of exploratory factor analysis is generally recommended against (Worthington & Whittaker, 2006) and interpretive guidelines for confirmatory factor analysis model fit have been endorsed (Brown, 2006; Hu & Bentler, 1999; Jackson, Gillaspay, & Purc-Stephenson, 2009). Multiple indexes of model fit are required with specific cut-offs for acceptable and good model fit. For the root mean square error of approximation (RMSEA), less than .70 indicates acceptable model fit and less than .50 indicates good model fit. Comparative-fit index (CFI) and Tucker-Lew index (TLI) values greater than .90 indicate acceptable fit and values greater than .95 indicate good model fit. For composite reliability, the internal consistency with which a construct is measured, a

cut-off of .70 is recommended (Fornell & Larcker, 1981). Composite reliability has been described as superior to other reliability estimates because it indicates the internal consistency with which a construct is measured, as opposed to item reliability (Fornell & Larcker, 1981; Hair, Anderson, Tatham, & Black, 1998).

The vast majority of psychometric research has focused on the statistical properties of scales. However, it is pertinent that issues of subjectivity, neutrality, cardinality, and arbitrariness are considered (Blanton & Jaccard, 2006; Kristoffersen, 2010). Subjectivity is a threat to content validity, as different people are likely to interpret the same item in different ways (Blanton & Jaccard, 2006). van Praag (2007) suggested that this is resolved when respondents share cultural and linguistic backgrounds. Therefore, at the cost of generalisability, scales should initially be developed for a single population.

Unlike subjectivity, other metric considerations do not have incidental resolutions. Arbitrariness relates to not knowing how test scores relate to the actual construct and how changes on a scale relate to changes in the construct (Blanton & Jaccard, 2006). This is similar to cardinality, which is the assumption that one-unit changes in a scale should relate to equidistant changes on the construct (Kristoffersen, 2010). These assumptions are inherently failed by imposing numerical units of measurement but can be remediated by improving the predictive validity of a scale (Blanton & Jaccard, 2006). Neutrality, on the other hand, is the assumption of a midpoint to indicate an average amount of a given construct (Kristoffersen, 2010), such as restraint. In the absence of a smoking restraint assessment tool and smoking restraint data, an average amount of restraint is unknown. Thus, what constitutes high and low restraint is also unknown. These distinctions have proven useful in the eating restraint and alcohol literature (Nguyen & Polivy, 2014; Tahaney et al., 2014), so it may be presumed equally beneficial to the smoking literature.

In summary, the development of psychological assessment tools requires consideration of conventional indicators of psychometric properties. These indicators must be supported by empirical literature and reported in a consistent manner to enable replication of a study's procedures. According to Cabrera-Nguyen (2010), the reporting of confirmatory factor analyses in peer-reviewed journals frequently omit vital information that enable replication and evaluation of the statistical procedures employed. Moreover, the development of questionnaires to assess psychological constructs must be grounded in theory and developed collaboratively by professionals familiar with the construct to ensure good content validity. Through careful consideration of the guiding literature to aide item generation for a given population, other psychometric assumptions may be satisfied, allowing for the collection of data that will enable interpretive classifications of varying amounts of the construct. For smoking restraint, this might identify cognitive and behavioural differences between smokers of high, medium and low restraint, which would likely prove beneficial to smoking reduction and cessation interventions.

Conclusion

Cigarette smoking is a heterogeneous behaviour that can have devastating impacts on an individual's health and wellbeing. It is the greatest global health concern and cause of preventable death, disease and economic burden. As a complex addictive behaviour, it is best conceptualised within a broad biopsychosocial model that incorporates behavioural, cognitive, biological, and pharmacological theories of substance dependence. Due to its complexity and impacts, understanding the correlates of smoking reduction and cessation is essential to developing effective treatment strategies that inevitably reduce the harms and costs of smoking. One such correlate may be restraint, which eating and alcohol researchers have successfully operationalised and identified as a potential target for treatment. The smoking literature has lagged in this area, presumably due to the absence of a smoking

restraint assessment tool. As smoking restraint refers to the ability to resist temptations to smoke, it is of likely benefit that interventionists better understand the construct so it may be integrated into existing treatments. To better understand the construct, it must be first operationalised through the development of an assessment tool that is consistent with expectations outlined in the psychometric literature. The existence of several alcohol and eating restraint self-report assessments suggest that smoking restraint may be similarly operationalised through self-report assessment. The benefits of such an assessment are that smoking restraint interventions will more closely follow the scientist-practitioner model and enable comparability of studies, and that researchers will better understand the correlates of a complex addictive behaviour to guide further research.

Development and Psychometric Properties of The Smoking Restraint Questionnaire

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Abstract

Objective. Restraint is a component of self-control that focuses on the deliberate reduction of an undesired behavior and is theorized to play a role in smoking reduction and cessation.

However, there exists no instrument to assess smoking restraint. This research aimed to develop the Smoking Restraint Questionnaire (SRQ) to meet this need.

Methods. Participants were 406 smokers (48% female; 52.2% non-daily) with a mean age of 38.83 years ($SD = 12.05$). They completed a baseline questionnaire designed to assess smoking restraint. They also completed 21-days of ecological momentary assessment (EMA), during which they recorded each cigarette smoked and answered questions related to planned restraint every morning, and restraint attempts every evening.

Results. The 4-item questionnaire of smoking restraint was found to fit a single factor ($RMSEA = .038$, $CFI = .99$, $TLI = .99$), and the resulting composite was reliable (composite reliability = 0.74). The questionnaire contains items that assess the setting of weekly restraint goals and attempts at not lighting up when tempted to smoke. Participant SRQ scores positively correlated with EMA data on plans to restrain ($p < .001$) and frequency of restraint attempts ($p < .001$). These correlations suggest that the SRQ has good predictive validity in relation to the intention and behaviors of smoking reduction.

Conclusions. The SRQ is promising as a measure of smoking restraint, and may enable further research and insights into smoking reduction and cessation.

Development and Psychometric Properties of The Smoking Restraint Questionnaire

As the leading cause of preventable death and disease in the developed world (Lim et al., 2012), cigarette smoking has become a global health concern. Smoking can cause serious illness, such as cancer, and heart and lung disease (Bellomi et al., 2010; Rachtan, 2002; Stellman et al., 2001). In general, smoking increases morbidity whilst decreasing life-expectancy (Brønnum-Hansen & Juel, 2001). In light of the adverse health outcomes there is considerable interest in understanding the correlates of smoking, including those related to reduced consumption.

Many mechanisms are theorised to enable smoking reduction and cessation, including self-control. Self-control can be defined as the ability to increase the occurrence of desirable behaviours or decrease the occurrence of undesirable behaviours (de Ridder et al., 2011). It is a broad construct that involves self-regulating thoughts, feelings, and behaviours. Similarly broad is the related concept of self-regulation, which is theorised to be a personality construct for which dispositional self-control is a prerequisite (Baumeister et al., 2006). These concepts propose that behaviour can be modified in line with a person's wishes. It is theorised that self-regulation is a distinctively human characteristic that evolved to suppress survival instincts that run counter to cultural longevity and morality (Baumeister, 2014).

Self-regulation that focuses solely on decreasing the occurrence of an undesired behaviour is typically referred to as restraint. Similar to self-regulation, restraint has been defined as the conscious, chronic restriction of a target behaviour based on personally set limits (Keller & Siegrist, 2014). Restraint has mostly been studied in the eating literature (e.g., binge-eating) where it can be accomplished through a variety of behaviour strategies, such as setting limits on daily and weekly caloric intake, avoiding places where eating is expected (planned restraint), or providing excuses when food is presented (situational restraint)(Moreno et al., 2009). Moreno et al. (2009) described the strategies as strict and self-

imposed, with some behaviour demonstrating temporal effectiveness. For example, refusal skills are essential to achieving restraint when it is momentarily required (Vandereycken & Van Humbeeck, 2008), whereas planning skills are essential to setting caloric intake restraint goals (Segura-García et al., 2014)

The eating definition of restraint is equivalent to that provided in the smoking literature, in that smoking restraint has been defined as a conscious, cognitive and behavioral ability to refrain from consumption (Nordgren et al., 2009). Craving often prompts smoking, so deliberately resisting smoking may require the application of immediate, situational restraint. Among smokers who have quit, temptations to smoke, characterized by strong craving, frequently present challenges to the individual's commitment to abstinence (Ferguson & Shiffman, 2009) and analysis shows that whether the person actually succumbs can be influenced by whether they implement restraint strategies (i.e., coping; Shiffman, 1982, 1984; Shiffman et al., 1996; van Osch et al., 2008). More strategic – or planned - restraint strategies that are not enacted at the moment of temptation, but distal to such critical moments, have also been described (i.e., "anticipatory coping"; van Osch et al., 2008; Wills & Shiffman, 1985).

Less has been studied about the role of restraint in smoking reduction, rather than complete cessation, but there has been increased interest in reduction, either as a harm-reduction strategy (Hamilton et al., 2005) or as a path to cessation (Shiffman et al., 2009). Studies show that smokers who are better able to reduce their smoking are also more likely to quit completely (Klemperer & Hughes, 2015; Moore et al., 2009) suggesting a link or continuity between restraint for reduction and for cessation.

Despite interest in the area, there is currently no smoking restraint assessment tool. This is disappointing given that restraint assessments have benefitted health outcomes and research in other areas (Jacobi et al., 2012). It is also surprising given that the construct was

theorized decades ago to account for smoking reduction (Herman, 1974). Furthermore, the existence of assessments for eating restraint and alcohol restraint indicate that the construct can be operationalized with good effect. For example, the Temptation and Restraint Inventory (Collins & Lapp, 1992), which is a brief self-report questionnaire that measures restraint from consuming alcohol, is predictive of weekly drinking and problematic drinking (Collins, Koutsky, & Izzo, 2000). Similarly, the Eating Disorder Examination – Questionnaire (Fairburn & Beglin, 1994), which was designed to assess one's ability to restrain oneself from exceeding caloric intake goals, among other constructs, has been used extensively in the literature to assess dietary restraint (Brewin, Baggott, Dugard, & Arcelus, 2014). Both tools have simple designs, in that restraint is represented as a single factor, and are used in clinical research to assess post-intervention outcomes and improve scientific understanding of behavior reduction (Jacobi et al., 2012; Jones et al., 2014). Thus, it is probable that a smoking restraint assessment tool will be similarly useful to study smoking reduction and cessation. Additionally, the absence of a tool has hindered interpretability and comparability of smoking restraint interventions given that the construct has not been operationalized (Kelly et al., 2010; Muraven, 2010).

The present research aims to develop a brief Smoking Restraint Questionnaire (SRQ). The goal was for the SRQ to have good psychometric properties; emphasis was placed on achieving good content validity through literature review and systematic item selection processes. To test the SRQ's predictive capacity, a simple scoring procedure was developed that allowed correlational analysis with data collected via Ecological Momentary Assessment (EMA) of actual smoking. It was hypothesised that scores on the SRQ would relate positively to self-report restraint plans, and to frequency of restraint attempts.

Method

Overview

The present data were drawn from a larger study examining smoking behavior in daily and non-daily smokers who were not interested in quitting smoking. Comprehensive descriptions of the sample, measures, and procedures have been provided elsewhere (Shiffman et al., 2013; Shiffman et al., 2014; Shiffman, Ferguson et al., 2012; Shiffman et al. 2012). Briefly, participants completed a baseline questionnaire, six cue reactivity sessions (see Shiffman et al., 2013) and monitored their smoking and activities for up to 21-days using a handheld electronic diary to implement EMA monitoring procedures. The University of Pittsburgh Institutional Review Board approved the study.

Participants

There were 406 participants who were either daily (47.8%) or non-daily (52.2%) smokers with a mean age of 38.83 years ($SD = 12.05$). Gender was approximately equal with 48% being female. Most participants identified as either Caucasian (62.6%) or African American (34.5%), and had never married (57.9%). Approximately 69% of the sample had post-high school education. On average, daily smokers had smoked for 25.69 years ($SD = 11.83$) and smoked 15.01 cigarettes per day ($SD = 5.86$). Non-daily smokers had smoked for an average of 19.25 years ($SD = 12.71$), 4.51 days per week ($SD = 1.64$), and smoked 4.45 cigarettes ($SD = 2.92$) on smoking days. Additional demographic and smoking history characteristics have been reported previously (see Shiffman et al., 2014).

Inclusion criteria were being at least 21-years old, smoking for at least 3-years, smoking at a consistent rate for at least 3-months, and having no plan to quit within the next month. Inclusion as a daily smoker required smoking between 5 and 30 cigarettes per day; inclusion as a non-daily smoker required smoking between 4 and 27 days per month with no

limit on number of cigarettes smoked. African-Americans were oversampled because they are more likely to be non-daily smokers than Caucasian Americans (Trinidad et al., 2009).

Materials and Procedure

After providing written informed consent, participants completed a baseline questionnaire addressing personal characteristics and smoking history. Within the questionnaire were eight items related to smoking restraint, defined as the ability to restrict cigarette intake based on personally determined limits (see Table 1). The items were created specifically for the measurement of restraint based on theory and a review of existing restraint scales in other areas.

Participants also completed 21-days of EMA monitoring during which they were asked to record every cigarette smoked and respond to randomly-timed assessments of mood, activities and social setting throughout the day. At the beginning of each day, participants completed a brief morning report where, among other items, they were asked to indicate whether they planned to limit the amount they smoked that day (scored on a 0[No]-100[Yes] scale). Similarly, at the end of each day, subjects were asked to complete an evening report designed to summarise their experiences over the day. Of relevance to the present study, participants were asked, “how many times did you feel like smoking but tried to resist?” (scored on a 0 – 10 scale then dichotomised [0 = no restraint, 1 = any restraint]).

Analytic Plan

We used a split-half validation method to assess the factor structure of the SRQ. A split-half variable stratified by smoker type (daily or nondaily smoker) was randomly assigned to participants to divide the sample. One half was analysed with an exploratory factor analysis and the other half was analysed with a confirmatory factor analysis; the latter tested stability of the factor structure identified via the exploratory analysis. The exploratory

and confirmatory factor analyses were conducted according to Costello and Osborne (2005) and Brown (2006) guidelines.

Given that the broader aim of the study was to generate a better understanding of restraint, a maximum likelihood factor analysis was employed. This method explores latent structures with the purpose of deriving a causal model (O'Rourke, Hatcher, & Stepanski, 2005). To prevent factor over-extraction scree plots were examined for a point of inflexion (Costello & Osborne, 2005). Items with loadings less than .32 were omitted (Tabachnick & Fidell, 2007). To be consistent with existing restraint scales in other domains, the analyses were run with specification of a single factor.

Findings from the exploratory factor analysis were used as a-priori hypotheses in the confirmatory factor analysis with the second split half. The analyses employed delta parameterisation due to its better management of categorical data than theta parameterisation (Muthén & Asparouhov, 2002), and weighted least squares estimation was specified to compensate for the non-normal distributions of categorical data (Muthén & Muthén, 1998-2012). To evaluate model fit, the root mean square of error approximation (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI) were assessed according to Hu and Bentler (1999) guidelines. As per the two step procedure (Anderson & Gerbing, 1988), composite reliability and average variance extracted (AVE) were calculated with the Fornell and Larcker (1981) formulae. Composite reliability indicates the reliability with which a construct is measured and reportedly overcomes several limitations imposed by Cronbach's alpha (Hair, et al., 1998).

Predictive validity was assessed with Pearson bivariate correlations between SRQ scores and EMA planned restraint and attempted restraint. Planned restraint was calculated as each participant's mean response to the morning report item asking about intentions to limit smoking during the coming day. Actual restraint was calculated as the percentage of days that

participants reported any attempt to restrain their smoking (assessed in the evening report).

As these variables were measured using the EMA methodology following completion of the baseline questionnaire, the data are likely to be an accurate reflection of actual behaviour and is therefore especially useful in determining predictive validity (Ferguson & Shiffman, 2011; Zwar, et al., 2011).

The restraint items (Table 1) had between zero and five cases missing (0-1.5%) with all considered missing completely at random. Multiple imputation replaced the missing data as per recommendations for factor analysis (Cabrera-Nguyen, 2010). Normality was violated for item 0b, the only continuous variable ($p < .001$). The data were subjected to square root, cubed root, and logarithmic transformations but no improvement in distribution shape was evident. The variable was retained as entered. Analyses were conducted in SPSS (version 21) and Mplus (Muthén & Muthén, 1998-2012).

[Insert Table 1 here]

Results

Psychometric Properties

Exploratory factor analysis.

The first split-half had a person-to-item ratio of 40.6:1, which is sufficient for statistical power (Pallant, 2011). Of the eight items (see Table 1), three were omitted following Tabachnick and Fidell (2007) guidelines. Two had unacceptable inter-item correlations and one item had a loading $< .32$. Upon removal of these items, the data met factorability requirements ($KMO = .73$; χ^2 for Bartlett's test of Sphericity = 304.42, $p < .001$; at least one significant inter-item correlation for all variables).

The one-factor model had post extraction communalities ranging from .11 to .72; therefore, no redundancies were indicated. The model explained 51% of the variance and

factor loadings ranged from .32 to .85 (Table 2). Two loadings were meaningful yet poor, and three were excellent (Comrey & Lee, 1992).

[Insert Table 2 here]

Confirmatory factor analysis and reliability

The assumption of model over-identification was met as the single factor included more than the required minimum of four items (Brown, 2006). The hypothesised model was a poor fit to the data (RMSEA = .17, CFI = .96, TLI = .92), so the model was respecified by alternatively removing items 0d and 2. These items were chosen given their conceptual overlap. The best model fit included item 2, which assessed setting weekly restraint goals (RMSEA = .038, CFI = .99, TLI = .99). This was better than including the item that assessed setting daily restraint goals (RMSEA = .13, CFI = .98, TLI = .93), which is unsurprising given that daily restraint goals may not apply to non-daily smokers. Table 3 reports the standardized and unstandardized model estimates, which were good and supported convergent validity (Brown, 2006). Using the two-step approach (Anderson & Gerbing, 1988), acceptable convergent validity and internal consistency was demonstrated (composite reliability = .74, AVE = .42; Malhotra & Dash, 2011).

[Insert Table 3 here]

Predictive Validity

As good reliability and factor structure was achieved, the predictive capacity of the SRQ was investigated. The predictive validity data were collected each morning and evening over a three-week period following administration of the baseline questionnaire. As the ecological validity of self-reported EMA data is very good (Serre, Fatseas, Swendsen, &

Auriacombe, 2015), correlating daily restraint plans and attempts with SRQ scores was deemed an effective analytical strategy to assessing predictive validity.

To run the correlations, each participant's SRQ score was calculated as the sum of the questionnaire items, where binary items were converted to 1 = No and 5 = Yes (final scores could range from 4 – 20; see Appendix). As expected, there was a significant positive correlation between SRQ scores and both plans to restrain ($r^2 = .15, p < .001$) and percentage of days restrained ($r^2 = .10, p < .001$). This means that participants with higher SRQ scores were more likely to plan and attempt to reduce their cigarette intake than participants' with lower SRQ scores.

Discussion

This study developed the SRQ, which is the first known smoking restraint questionnaire. Content validity was achieved via a structured item evaluation procedure that involved a literature review of restraint and examining existing restraint assessment tools. A single factor model was derived in exploratory factor analysis and, following respecification, was supported in confirmatory factor analysis. The final questionnaire was reliable and the hypothesis that SRQ scores would predict plans to restrain over 21-days of EMA was supported. The hypothesis that SRQ scores would relate to attempted restraint over this period was also supported. As a whole, the findings indicate that the SRQ has good predictive validity and psychometric properties.

The SRQ items reflect definitional and operational aspects of restraint in the existing literature. The eating and alcohol literature define restraint as a conscious, chronic restriction of intake based on personally set limits (Collins et al., 2000; Keller & Siegrist, 2014) and repeatedly makes note of individuals both setting plans of allowed intake, and also enacting situationally based behaviours to achieve these goals (Collins & Lapp, 1992; Moreno et al., 2009; Vandereycken & Van Humbeeck, 2008). Similarly, the SRQ includes items related to

both planning and situational smoking restraint behaviours. The temporally relevant factor structure of proximal and distal restraint behaviours may inform clinical practice as quitters could be encouraged to set weekly limits on their cigarette intake. For example, a smoker may set a plan to ration or limit smoking, but then fail to resist smoking on any particular occasion. They could still achieve their weekly smoking reduction goal by re-attempting restraint later that week. Further, the single factor structure is consistent with existing restraint scales (Fairburn & Beglin, 1994; Ruderman & McKirnan, 1984), suggesting that this new measure is compatible with the literature and may enable further investigation into the restraint construct as it relates to addictive behaviour and smoking reduction.

Although smoking restraint is a relatively new concept, the alcohol restraint research identifies the construct to be of clinical importance in drinking reduction and as a potential target for treatment (Jones et al., 2011; Tahaney et al., 2014). Indeed, smoking reduction and cessation interventions have found that teaching coping skills improves success rates (van Osch et al., 2008). This is consistent with observational studies that found that the use of cognitive and behavioral coping strategies is related to successful restraint during cigarette craving (Shiffman, 1982, 1984; Shiffman et al., 1996). Due to the development of the SRQ, research into smoking reduction and cessation may be furthered, as the restraint construct has been successfully operationalised. Major strengths to the SRQ are its brevity, simple scoring procedure, and that it was developed using a large sample of both daily and non-daily smokers. The latter is important given the recent interest in non-daily smoking patterns and the multitude of differences observed between daily and non-daily smokers (Coggins, Murrelle, Carchman, & Heidbreder, 2009; Reitzel, Buchanan, Nguyen, & Ahluwalia, 2014; Shiffman et al., 2014; Shiffman, Tindle et al., 2012; Sutfin et al., 2012; Tindle & Shiffman, 2011). Additionally, the use of three-week EMA data to analyse predictive validity is a

significant strength to this study, as it was demonstrated that SRQ scores relate day-to-day intentions and behaviors.

However, this study is not without limitations. The use of split-halves within a single sample in this study provides promising evidence of the utility of the SRQ, but stronger evidence would come from a study that yielded converging results with a larger, more diverse sample. Additionally, the absence of data on actual smoking reduction or cessation leads to interpretive limitations; future studies will be necessary to determine whether restraint as measured by the SRQ is predictive of reduction and cessation outcomes.

In conclusion, this study reports the development of the SRQ, a brief self-report questionnaire of smoking restraint for which preliminary evidence suggests there is good psychometric properties and predictive validity. Future researchers may wish to investigate the SRQ's test-retest reliability to determine its capacity to monitor change. Additionally, the relationship between smoking restraint and cigarette consumption should be examined as to enhance our understanding of successful cessation and therefore enable improved health outcomes. It is recommended that this be done alongside smoking reduction and cessation programs so that claims regarding the manipulation of restraint may be empirically evaluated.

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Table 1.

Final Item Pool

Code	Item (<i>Response</i>)	Outcome
0a	When you are tempted to smoke, but want not to, what sorts of things do you THINK in order to keep from smoking? Put a limit on how much you're allowed to smoke. (<i>Yes, No</i>)	Failed inter-item correlation assumption
0b	Considering only the occasions when you feel you shouldn't smoke, what percent of the time do you go ahead and smoke the cigarette anyhow? (<i>0-100</i>)	Failed inter-item correlation assumption
0c	How often do you smoke your cigarette halfway or limit how many puffs you take in an effort to limit your smoking? (<i>1 = Never, 2 = Less than once per day, 3 = 1-2 times per day, 4 = 3-10 times per day, 5 = More than 10 times per day</i>)	Poor factor loading
0d	Do you have a limit or target that you set for yourself of how many cigarettes to smoke in a <u>day</u> ? (<i>Yes, No</i>)	Omitted during respecification
1	Do you ever try to limit the number of cigarettes you smoke? (<i>Yes, No</i>)	Included in final model
2	Do you have a limit or target that you set for yourself of how many cigarettes to smoke in a <u>week</u> ? (<i>Yes, No</i>)	Included in final model
3	Do you plan out or ration your cigarettes for each day or week? (<i>1 = Never to 5 = Always</i>)	Included in final model
4	How often do you deliberately refrain from lighting up a cigarette to keep your smoking rate down? (<i>1 = Never, 2 = Less than once per day, 3 = 1-2 times per day, 4 = 3-10 times per day, 5 = More than 10 times per day</i>)	Included in final model

Table 2.

Correlations, Communalities and Factor Loadings from Exploratory Factor Analysis

Variable	0a	0b	0c	0d	1	2	3	4	Communalities	Factor Loadings
0a	-								-	-
0b	-.10	-							-	-
0c	.04	.06	-						-	-
0d	..15	-.03	.18	-					.51	.71
1	.23	-.10	.26		-				.10	.33
2	.10	-.02	.11	.32	.11	-			.72	.85
3	.16	.03	.15	.51	.25	.36	-		.64	.80
4	.16	.001	.45	.34	.37	.17	.30	-	.13	.36

Notes. Results are from participants in the first stratified split half.

Loadings greater than .30 are considered statistically significant (Brown, 2006).

Table 3.

Standardized and Unstandardized Model Parameters from Confirmatory Factor Analysis

Item	Standardized model			Unstandardized model		
	Factor loading	Standard error	<i>p</i>	Factor loading	Standard error	<i>p</i>
1	.75	.10	< .001	1	0	.999
2	.53	.08	< .001	.70	.16	< .001
3	.64	.06	< .001	.85	.13	< .001
4	.66	.07	< .001	.88	.17	< .001

Appendix A

The Smoking Restraint Questionnaire and Scoring Procedure

	Assigned numerical value				
	1	2	3	4	5
1. Do you ever try to limit the number of cigarettes you smoke?	No				Yes
3. Do you have a limit or target that you set for yourself of how many cigarettes to smoke in a <u>week</u> ?	No				Yes
4. Do you plan out or ration your cigarettes for each day or week?	Never	Almost never	Sometimes	Often	Always
5. How often do you deliberately refrain from lighting up a cigarette to keep your smoking rate down?	Never	Less than once per day	1-2 times per day	3-10 times per day	More than 10 times per day

Scoring the Smoking Restraint Questionnaire

The two binary questions of the Smoking Restraint Questionnaire are scored 1 (No) and 5 (Yes). The two multiple-choice items are scored from 1 to 5.

Total smoking restraint is calculated as the sum of the four items. The minimum possible score is 4 and the maximum possible score is 20.

Appendix B

Journal of Addictive Behaviors – Response to Reviewers

13/08/2015

Dear Dr McKee,

Please find attached our revised paper titled “Development and Psychometric Properties of The Smoking Restraint Questionnaire” (ADB-2015-0666) for consideration as a research article in *Psychology of Addictive Behaviours*. As with the original submission, all authors of this manuscript have read and followed the Instructions for Authors. The authors have reviewed this manuscript and have approved submission. This manuscript has not been published and is not currently submitted elsewhere. The data reported in this manuscript are part of several larger studies; a reference list of additional manuscripts from these data sets is provided at the end of this letter.

While both reviewers were rather positive about aspects of our original submission, they nevertheless recommended a number of changes and clarifications. Below we list each of the reviewers’ comments, and our responses.

Reviewer #1

1. The paper is well written and makes sense, and after a first read I was going to recommend major revisions. The researchers clearly know what they are doing and have done this kind of work before. But after I re-evaluated the paper, I realized they describe the development of the measure but provide very little data that it is valid and reliable. I would have concerns about publishing a measure that will likely get used quite a bit without more confidence that it is a good measure.

We agree with the reviewer that demonstrating reliability and validity is critical to determining the scientific value of an assessment tool. We have addressed these concerns in the revisions by 1) making clearer how validity was demonstrated and 2) adding data about reliability and convergent validity.

Firstly, with regard to the issue of validity, we have revised the manuscript to emphasise the relationship between SRQ scores and real-world behaviour, as documented via real-time EMA recording. The most obvious and theoretically sensible validation of a smoking restraint measure is the degree to which smokers actually attempt to restrain their smoking in their day-to-day life; this is the outcome that we used to test the validity of our newly developed scale. The use of ecological momentary assessment to determine predictive validity, we believe, is a key strength of our study. This research methodology has been demonstrated to be especially useful in the smoking cessation literature to predict lapse and relapse (Zwar, et al., 2011). A recent systematic review of the substance use literature concluded that ecological momentary assessment can be used to collect high quality, valid data (Serre, et al., 2015). As this aspect of data collection took place for three weeks following administration of the baseline questionnaire, correlations between SRQ scores

and the ecological data, we believe, is an excellent strategy to investigate predictive validity. We have revised the manuscript to clarify this point (in particular, see pages 8, 10 & 12). We hope that these changes to the manuscript make clearer the steps we took to validate the scale. We also now report evidence of good (Malhotra & Dash, 2011) convergent validity (see page 9).

We have also revised the manuscript to include a measure of composite reliability. Composite reliability was chosen as it has been described as superior to other reliability estimates (Fornell & Larcker, 1981). In the revised manuscript, we justify the use of composite reliability (page 7) and report that the composite reliability of the SRQ surpassed the recommended cut-off (Fornell & Larcker, 1981).

In sum, the manuscript has been substantially revised to provide evidence of convergent validity and reliability, and to more clearly describe the steps taken to demonstrate predictive validity. We hope that these revisions will be sufficient to allay concerns about the reliability and validity of the scale.

Reviewer #2

1. Given that this manuscript utilized data from daily and non-daily smokers, did the authors consider investigating whether the SRQ differentially predicted smoking restraint in daily vs. non-daily smokers?

This is a very good question. We have indeed examined whether daily and nondaily smokers differ in terms mean SRQ scores. They do not. We also do not see differences between the groups in the relationship between SRQ scores and observed restraint during monitoring.

However, given that this study aims to report psychometric properties of the SRQ, we believed that describing the restraint construct in relation to smoking frequency is out of scope of the current study. Setting up the theoretical rationale for such an analysis would require the introduction to be substantially expanded; we do not believe that this is warranted given the primary objective of the paper. Importantly, we considered that, because there is not a clear theoretical prediction or empirical precedent, no pattern of findings would establish or refute the validity of the measure: daily smokers might be more restrained, less restrained, or (as we eventually found) equally restrained as non-daily smokers. We have, however, noted in the discussion that more research is required comparing restraint in daily and non-daily smoker.

2. Regarding demographic characteristics, the authors reported participants' mean age and gender. It would benefit future research to include information on sociodemographics and SES-related factors (i.e., race/ethnicity, education, income, relationship status).

Thank you for your feedback with regard to this. Although it was noted that more detailed demographic data was reported in our related studies, the paper has been amended to include additional demographic data, including race/ethnicity, education, and relationship status. These data are now reported in the Participants section (page 5).

3. Two typos were noted:
- Page 7, 2nd paragraph, 2nd sentence: Add "to" between "do" and "its"
 - Page 9, 1st paragraph of the Discussion, 4th sentence: In the sentence, "The hypothesis that SRQ scores would predict plans to restraint over..." I believe that "restraint" was meant to be "restrain."

The typing errors have been corrected in the revised manuscript. Thank you for your feedback and attention to detail.

We believe that the manuscript is improved as a result of the revisions made and that the findings presented will make an important contribution to the literature by enabling further investigation into the restraint construct. We hope that, with these changes, the paper will be deemed acceptable for publication.

Kind regards

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Dear Dr McKee:

Please find attached our revised paper titled “Development and Psychometric Properties of The Smoking Restraint Questionnaire” (ADB-2015-0666R1) for consideration as a research article in *Psychology of Addictive Behaviours*. While both Reviewers responded positively to our first revision, Reviewer 1 had two additional comments on our manuscript. Below we list each of these comments, and our responses.

Reviewer #1

1. The lack of descriptive statistics on the SRQ do not allow the reader to gain a sense of its distributional properties.

In response to the Reviewers comment, we now report the mean, standard deviation and range of observed SRQ scores ($M = 9.65$, $SD = 3.80$, Range: 4 - 19). These values are reported on page 11 of the revised manuscript.

2. In the discussion, it would be helpful if the authors addressed the fact that the measures of daily restraint only correlated modestly with the SRQ ($r = .39$ and $.31$).

As requested, we have now included a section discussing the fact that the observed correlations between the SRQ and self-reported restraint behaviour were relatively modest (see page 12). We note that restraint is a complex construct and numerous factors (e.g., cigarette availability, social pressures etc) likely contribute to whether one actually restrains on a moment-to-moment basis, so the observed correlation between SRQ scores and real-world restraint behaviour is not completely unexpected. We note that the correlations observed are comparable—indeed slightly stronger—than those observed between widely used questionnaires of smoking motives and patterns and EMA-assessed smoking patterns, and between laboratory-based measures of cue reactivity and EMA-observed reactivity.

We believe that the manuscript is improved as a result of the revisions made and that the findings presented will enable further investigation into the restraint construct. We look forward to hearing from you in due course.

Kind regards

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